Claims

What is claimed is:

1. A device, comprising:

an interface member including a material;

a manipulandum movable in a degree of freedom, the manipulandum configured to penetrate the material;

a sensor configured to output a position signal based on the position of the manipulandum; and

an actuator configured to output haptic feedback by applying a compressive force to the material based on the position signal.

2. The device of claim 1, wherein the material includes a plurality of compressible beads.

3. The device of claim 1, wherein the material includes a plurality of polystyrene beads.

4. The device of claim 1, wherein the interface member includes a simulated bone structure.

5. The device of claim 1, wherein the material includes a first layer having its own density and a second layer having its own density different from the density of the first layer, the manipulandum configured to penetrate the first layer and the second layer of the material.

6. The device of claim 1, wherein the actuator is a clamp coupled to the interface member.

7. The device of claim 1, wherein the actuator is a vacuum coupled to the interface member.

8. The device of claim 1, the actuator being a first actuator, the device further comprising a plurality of actuators including the first actuator, each actuator from the plurality of actuators being an individually actuatable clamp.

9. A device, comprising:

a manipulandum movable in a degree of freedom;

a sensor configured to output a position signal based on a position of the manipulandum;

a retainer defining an interior in which a material is disposed, the material configured to receive an object moved by the manipulandum; and

an actuator coupled to the retainer, the actuator configured to output haptic feedback via the retainer based on the position signal.

10. The device of claim 9, wherein the manipulandum includes a first portion and a second portion, the second portion configured to be removably coupled to the object.

11. The device of claim 9, wherein the manipulandum is configured to move in a rotary degree of freedom about an axis, and move simultaneously along the axis.

12. The device of claim 9, wherein the interface member includes a simulated pedicle of a vertebrae.

13. The deice of claim 9, wherein the interface member includes a simulated bone structure.

14. The device of claim 9, wherein the retainer is configured to compress the material in response to actuation of the actuator.

15. The device of claim 9, wherein the retainer is configured to modify a density of the material based on the position signal.

16. The device of claim 9, wherein the retainer is a clamp having an opening, the actuator including a motor configured to modify a size of the opening based on the position signal.

17. The device of claim 9, wherein the manipulandum is a screwdriver and the object is a screw.

18. The device of claim 9, further comprising:

a guide configured to receive at least a portion of the manipulandum, the guide being removably coupled adjacent to the retainer.

19. The device of claim 9, wherein the manipulandum is movable in two degrees of freedom.

20. The device of claim 9, wherein the manipulandum is movable in a rotary degree of freedom and a linear degree of freedom.

21. A device, comprising:

a manipulandum;

a sensor configured to output a position signal associated with a position of an object engaged by the manipulandum, the position signal being based on a position of one of the manipulandum and the object;

a retainer defining an interior in which a material is disposed, the material configured to receive at least a portion of the object; and

an actuator coupled to the retainer, the actuator configured to output haptic feedback by varying a density of the material via the retainer based on the position signal.

22. The device of claim 21, wherein the retainer is a clamp configured to vary the density of the material.

23. The device of claim 21, wherein the retainer is a housing configured to vary the density of the material.

24. An interface member for use with a haptic feedback device including a manipulandum movable in a degree of freedom, the interface member configured to be penetrated by the manipulandum, a sensor configured to output a position signal based on the position of the

manipulandum, and an actuator coupled to the interface member and configured to apply a compressive force based on the position signal, the interface member comprising:

a material portion, the material portion configured to be penetrated by at least a portion of the manipulandum, the material portion being subject to the compressive force by the actuator in response to the position signal.

25. The interface member of claim 24, further comprising a simulated bone structure.

26. The interface member of claim 24, wherein the material portion includes a plurality of compressible beads.

27. The interface member of claim 24, wherein the material portion includes a plurality of polystyrene beads.

28. The interface member of claim 24, wherein the material includes a first layer having its own density and a second layer having its own density different from the density of the first layer.

29. A device, comprising:

a body member including a membrane;

an interface material coupled adjacent the membrane;

a first guide defining a channel therethrough, the first guide configured to be inserted in the body member through the membrane at a first location;

a second guide defining a channel therethrough, the second guide configured to be inserted in the body member through the membrane at a second location;

a manipulandum configured to be removably inserted in at least one of the first guide and the second guide;

a position sensor configured to output a position signal based on a position of the manipulandum; and

an actuator coupled to the interface material and configured to output haptic feedback via the haptic feedback member based on the position signal.

30. A method, comprising:

receiving a position signal associated with a position of a manipulandum, at least a portion of the manipulandum penetrating the interface material; and

outputting haptic feedback by varying a density of the interface material based on the position signal.

31. The method of claim 30, wherein the varying the density includes applying a compressive force to the interface material via an actuator.

32. The method of claim 30, wherein the varying the density includes applying a vacuum to the interface material via an actuator.